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Predicted Weights and Volumes of Scarlet Oak Trees on the Tennessee Cumberland Plateau

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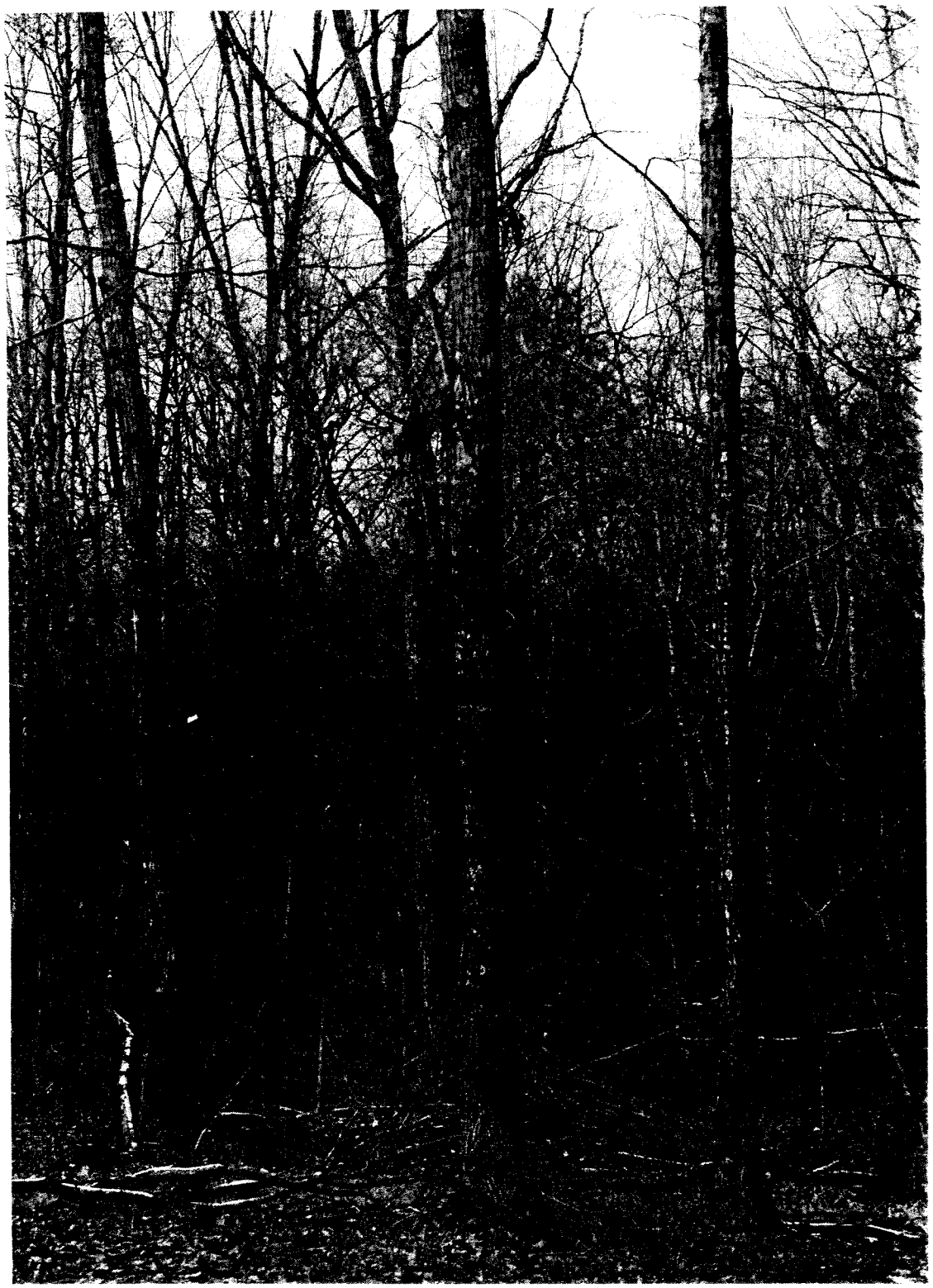

Conversion factors: English to metric

Multiply	*By*	*To obtain*
Inches	2.540	centimeters
Feet	.3048	meters
Pounds	.4536	kilograms
Cubic feet	.02832	cubic meters
Pounds per cubic foot	16.02	kilograms per cubic meter

All English units of measure in this report can be converted to metric units by multiplying by the appropriate conversion factor listed above.

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Predicted Weights and Volumes of Scarlet Oak Trees on the Tennessee Cumberland Plateau[1]

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ABSTRACT.—Total weights and volumes above stumps were determined for 28 scarlet oak (*Quercus coccinea* Muenchh.) trees 5 to 20 inches d.b.h. growing on the Tennessee Cumberland Plateau. Equations are presented for predicting green and dry weight and green volume of the total tree and its components using d.b.h. and total height, d.b.h. and height to a 4-inch top, d.b.h. and saw-log merchantable height, and d.b.h. alone. Tables developed from equations show weight and volume of the total tree and its components by d.b.h. and total height classes. Seventy-two percent of the average tree's green weight was in stem material to a 4-inch top, and 28 percent was in crown material. Total-tree wood had an average specific gravity of 0.608, average moisture content of 76 percent, and average green weight per cubic foot of 67 pounds. The weight of wood and bark averaged 79 pounds per cubic foot of wood for the total tree.

Keywords: *Quercus coccinea* Muenchh., biomass, component proportions, equations, specific gravity, moisture content, weight per cubic foot.

Forest trees are one of this country's most important renewable resources and must be utilized efficiently to meet increasing demands for solid wood, fiber, and energy. Utilizing the total tree above stump compared to utilizing only the merchantable saw-log stem can increase individual hardwood tree yields by 10 to 65 percent (Clark 1978). Equations for estimating the weight and volume of the total tree are needed to adequately evaluate and utilize scarlet oak (*Quercus coccinea* Muenchh.) trees. Wiant and others (1977) and Ford (1976) developed stem and total-tree weight equations for scarlet oaks in the northern Appalachian Mountains but not for scarlet oak in central Tennessee.

This Paper presents green volumes and green and dry weights of above stump biomass of commercial-size scarlet oaks growing in an uneven-aged stand in north-central Tennessee. Equations and yield tables predict weight and volume of the total tree and its components (wood, bark, saw logs, stem, and crown). Wood and bark specific gravity, moisture content, and green weight per cubic foot are presented for the total tree and its components.

PROCEDURE

FIELD

A stratified random sample of 28 scarlet oak trees was selected from a natural, closed, uneven-age stand of mixed oak with no evidence of fire

[1]This study was conducted in cooperation with and through the financial assistance of the Division of Forestry, Fisheries and Wildlife Development, Tennessee Valley Authority, Norris, Tennessee. Cooperation and assistance were also received from the Catoosa Wildlife Management Area personnel of the Tennessee Wildlife Resources Agency.

damage. The stand sampled had an average site index of 70 and was located on the Catoosa Wildlife Management Area in Cumberland County, Tennessee. Two to four trees were selected from each two-inch d.b.h. class from 6 to 20 inches. Form class of the sawtimber trees sampled ranged from 77 to 83 and averaged 80. The trees sampled ranged from 37 to 80 years old and averaged 53 years old. Means and ranges of tree measurements are shown in table 1.

Table 1.—Means and ranges in dimensions of scarlet oak trees sampled in Cumberland County, Tennessee, by d.b.h. class

D.b.h. class (inches)	Sample trees	D.b.h.		Total height		Height to 4-inch d.i.b. top		Height to saw-log merchantable top[1]		D.o.b. at saw-log merchantable top	
		Average	Range	Average	Range	Average	Range	Average	Range	Average	Range
	Number	*Inches*		*Feet*						*Inches*	
6	4	5.9	5.1– 6.6	56	50–62	24	17–31	—	—	—	—
8	4	8.0	7.2– 8.5	64	58–70	38	35–42	—	—	—	—
10	4	10.1	9.1–10.9	68	62–73	43	37–51	—	—	—	—
12	4	12.0	11.5–12.3	69	62–75	46	42–52	22	13–25	9.7	9.1–10.6
14	4	14.2	13.2–14.8	82	73–87	57	50–62	31	21–45	11.3	10.2–12.7
16	4	15.9	15.0–16.8	86	80–94	63	59–68	34	27–40	12.2	11.5–12.8
18	2	17.5	17.1–17.9	87	83–90	66	63–69	34	27–41	13.4	12.9–13.9
20	2	19.7	19.3–20.0	84	84–84	65	64–66	30	26–34	15.0	15.0–15.1
All classes	28	12.1	5.1–20.0	73	50–94	48	17–69	29	13–45	12.5	9.1–15.1

[1]Height to 8-inch d.i.b. or saw-log merchantable top.

Trees were felled and limbed during the winter, and the main stem of each tree was bucked into merchantable saw logs and pulpwood. Saw logs 8 to 16 feet long were cut from the main stem to an 8-inch d.i.b. top or a degrading quality indicator such as large knots. Stem d.o.b. at a saw-log top averaged 12.5 inches (table 1). All material between the saw-log merchantable top and the 4-inch d.i.b. top was classed as "pulpwood," and material between the 4- and 2-inch d.i.b. top was classed as "topwood." The crown was cut up and separated into four categories: (1) extra large branches (≥ 4.0 inches d.o.b.), (2) larger branches (≥ 2.0 and < 4.0 inches d.o.b.), (3) medium branches (≥ 0.6 inches and < 2.0 inches d.o.b.), (4) small branches (≤ 0.5 inches d.o.b.). The tip of the stem (2 inches d.i.b. to top) was included as branch material in the analysis. Dead branches were cut from the bole and weighed separately. All crown material and pulpwood were weighed to the nearest quarter of a pound. Saw logs were weighed individually to the nearest pound.

Disks were removed from the butt of each sawtimber tree (trees ≥ 11.0 inches d.b.h.), at each saw-log bucking point, at the points where d.i.b. measured 8, 6, 4, and 2 inches, and from branches randomly selected from each branch-size category. In pulpwood-size trees (trees 5.0 to 10.9 inches d.b.h.), disks were cut from the butt of each tree, at quarter points to a 4-inch top, and where d.i.b. measured 2.0 inches. Each disk was sealed in a polyethylene bag for subsequent laboratory determination of moisture content, specific gravity, and bark percent.

LABORATORY

Specific gravity of each wood and bark sample was computed on a green volume and ovendry weight basis. Moisture content was computed on an ovendry basis after samples were dried to a constant weight at 103° C. Percentage of bark was determined from disks on a green weight basis. Moisture content, specific gravity, and percentage of bark in stem, branches, and total tree were calculated by weighting disk values in proportion to the volume of the component they represented. Weighted values for moisture content were used to convert component green weight to ovendry weight.

Green weight per cubic foot of wood and bark were calculated from weighted values for specific gravity and moisture content with the equation:

$$\text{Green weight per cubic foot} = [1 + \text{M.C.}/100] \times (\text{S.G.}) \times (C) \qquad (1)$$

where:

M.C. = weighted moisture content in percent
S.G. = weighted specific gravity
C = 62.4 pounds (weight of water per cubic foot)

Cubic-foot volumes of green wood and bark were computed by dividing component weight by its green weight per cubic foot. Green cubic-foot volume (wood and bark combined) was computed by adding the green volume of wood to the green volume of bark.

ANALYSIS

Linear regression equations were developed to predict green and dry weights and green volumes of wood and bark in the total tree and its components. Independent variables were: diameter at breast height (D), total height (Th), merchantable height (Mh), and height to a 4-inch top (H4), both separately and in various combinations. Grouping the data into D^2 and D^2Th Classes and plotting the variance of Y over D^2 and D^2Th indicated that the variance of predicted weights and volumes increased with increasing D^2 and D^2Th. A logarithmic transformation (to the base 10) was used to obtain a relatively homogeneous variance which is assumed in regression analysis. Thus, regression equations for tree and component weights and volumes were calculated using the equations:

$$\log Y = b_0 + b_1 \log X + \epsilon \quad (2)$$

$$\log Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + \epsilon \quad (3)$$

where:

Y = weight or volume of component

X = D^2, D^2Th, D^2H4, or D^2Mh

$X_1 = D^2$

X_2 = Th, H4, or Mh

ϵ = sampling error

b_i = regression coefficients

When logarithmic estimates are converted back to original units they are biased downward because the antilogarithm of the estimated means gives the geometric rather than the arithmetic mean (Cunia 1964). To account for this bias, a correction factor was computed using a procedure described by Baskerville (1972) and applied to each equation. The forms of the equations, including the correction factor, are:

$$Y = 10^{b_0 + b_1 \log X + \frac{S^2_{y \cdot x}}{2}} \quad (4)$$

and

$$Y = 10^{b_0 + b_1 \log X_1 + b_2 \log X_2 + \frac{S^2_{y \cdot x}}{2}} \quad (5)$$

where:

$S^2_{y \cdot x}$ = error mean square from regression analysis

Equations (4) and (5) were simplified to:

$$Y = aX^{b_i} \quad (6)$$

and

$$Y = aX_1^{b_1} X_2^{b_2} \quad (7)$$

where:

$$a = 10^{b_0 + \frac{S^2_{y \cdot x}}{2}}$$

PROPERTIES OF SAMPLE TREES

TOTAL-TREE COMPONENTS

Green weight of the trees sampled ranged from 406 pounds for 6-inch trees to 6,547 pounds for 20-inch trees. Assuming the trees were composed solely of wood, bark, and water, 42 percent of their green weight was water; 48 percent was wood; and 10 percent was bark. The proportions of wood and bark in the total tree did not vary significantly with tree size. The proportions of total-tree weight in bark ranged from 15 to 17 percent, averaging 16 percent on a green basis. Wood made up an average of 83 percent of total-tree dry weight, and bark 17 percent.

The proportion of green weight in crown material (all live branches and topwood) ranged from 26 to 35 percent and did not vary consistently with tree size. The proportion of green weight in the stem to a 4-inch d.i.b. top averaged 72 percent and proportion in crowns averaged 28 percent. Seventy percent of the tree's dry weight was in stem material and 30 percent was in crown material.

The proportion of total-tree green weight in

dead branches ranged from 3 to 5 percent and did not vary with tree size. The proportion of dead branches averaged 3 percent on a green basis and 4 percent on a dry basis.

The green and dry weights of all wood and bark in the tree and the distribution of wood and bark throughout the tree are presented in tables 2 and 3. Sawtimber-size trees on the average had 74 percent of their green wood weight in the stem to a 4-inch top and 26 percent in the crown. Fifty-two percent of their green wood weight was saw-log material and 22 percent was pulpwood. Pulpwood-size trees had 72 percent of their total green wood weight in the stem to a 4-inch top and 28 percent crown.

Wood and bark are not distributed evenly throughout the tree. For example, the stem to a 4-inch top of the average pulpwood-size tree contained 72 percent of all the green wood in the tree but only 62 percent of the green bark. On the other hand, branches contained 17 percent of the green wood compared to 28 percent of the green bark. The proportion of green wood in branches increased with increasing tree size and ranged from 12 percent in 6-inch trees to 28 percent in 20-inch trees. The proportion of total-tree green bark weight in branches also increased with tree size, ranging from 22 percent in 6-inch trees to 45 percent in 20-inch trees.

STEM COMPONENTS

The main stem to a 4-inch top had 86 percent of its green weight in wood and 14 percent in bark,

Table 2.—Average green and dry weight of wood in the total tree and distribution of wood in main stem[1] and live branches in scarlet oak trees

D.b.h. class (inches)	Average total height	Sample trees	Total-tree wood weight	Proportion of wood in—								
				Main stem				Live branches (inches d.o.b.)				
				Saw log[2]	Pulp-wood[3]	Top-wood	Total stem	≥ 4	< 4 & ≥ 2	< 2 & > 0.5	≤ 0.5	All branches
	Feet	*Number*	*Pounds*	..... *Percent*								
				GREEN PULPWOOD								
6	56	4	340	—	67	21	88	—	0	9	3	12
8	64	4	680	—	74	8	82	—	4	11	3	18
10	68	4	1,250	—	75	4	79	—	8	10	3	21
Average	—	—	757	—	72	11	83	—	4	10	3	17
				GREEN SAWTIMBER								
12	69	4	1,871	44	29	2	75	2	10	11	2	25
14	82	4	3,072	52	22	1	75	7	9	8	1	25
16	86	4	3,807	56	18	1	75	9	8	6	2	25
18	87	2	4,763	54	21	1	76	9	8	5	2	24
20	84	2	5,475	51	21	[4]0	72	10	9	7	2	28
Average	—	—	3,468	52	22	1	75	7	9	7	2	25
				DRY PULPWOOD								
6	56	4	194	—	65	22	87	—	0	10	3	13
8	64	4	395	—	73	8	81	—	4	11	4	19
10	68	4	711	—	74	4	77	—	9	11	3	23
Average	—	—	433	—	71	11	82	—	4	11	3	18
				DRY SAWTIMBER								
12	69	4	1,078	43	28	2	73	2	10	13	2	27
14	82	4	1,754	50	22	1	73	8	9	9	1	27
16	86	4	2,130	54	18	1	73	9	9	7	2	27
18	87	2	2,696	53	20	1	74	9	9	6	2	26
20	84	2	3,006	49	20	[4]0	69	10	11	8	2	31
Average	—	—	1,953	50	21	1	72	8	10	8	2	28

[1]Main stem to 2-inch d.i.b. top.
[2]Saw logs to 8-inch d.i.b. or saw-log merchantable top.
[3]Pulpwood in stem from butt or saw-log top to 4-inch d.i.b. top.
[4]Less than one-half of one percent.

Table 3.—Average green and dry weight of bark in the total tree and distribution of bark in main stem[1] and live branches in scarlet oak trees sampled

D.b.h. class (inches)	Average total height	Sample trees	Total-tree bark weight	Proportion of bark in—								
				Main stem				Live branches (inches d.o.b.)				
				Saw log[2]	Pulp-wood[3]	Top-wood	Total stem	≥ 4	< 4 & ≥ 2	< 2 & > 0.5	≤ 0.5	All branches
	Feet	*Number*	*Pounds*	..... *Percent*								
				GREEN PULPWOOD								
6	56	4	66	—	57	21	78	—	0	16	6	22
8	64	4	136	—	62	7	69	—	4	18	9	31
10	68	4	238	—	67	3	70	—	11	13	6	30
Average	—	—	146	—	62	10	72	—	5	16	7	28
				GREEN SAWTIMBER								
12	69	4	360	37	24	2	63	3	12	17	5	37
14	82	4	541	41	19	1	61	9	11	14	5	39
16	86	4	718	45	17	1	63	11	11	11	4	37
18	87	2	860	45	18	1	64	11	11	11	3	36
20	84	2	1,072	38	16	1	55	12	13	14	6	45
Average	—	—	646	42	18	1	61	9	12	13	5	39
				DRY PULPWOOD								
6	56	4	41	—	58	21	79	—	0	15	6	21
8	64	4	86	—	63	8	71	—	4	17	8	29
10	68	4	151	—	67	3	70	—	11	13	6	30
Average	—	—	93	—	63	10	73	—	5	15	7	27
				DRY SAWTIMBER								
12	69	4	227	37	25	2	64	3	12	17	4	36
14	82	4	340	41	18	2	61	9	11	14	5	39
16	86	4	451	46	16	1	63	11	11	11	4	37
18	87	2	540	44	18	1	63	11	12	11	3	37
20	84	2	666	39	16	1	56	12	13	13	6	44
Average	—	—	405	42	18	1	61	9	12	13	5	39

[1]Main stem to 2-inch d.i.b. top.
[2]Saw logs to 8-inch d.i.b. or saw-log merchantable top.
[3]Pulpwood in stem from butt or saw-log top to 4-inch d.i.b. top.

while 85 percent of the dry stem weight was wood and 15 percent bark. The proportion of stem weight in wood and bark did not vary significantly with tree size.

CROWN COMPONENTS

The proportion of crown green weight in bark ranged from 20 to 24 percent but did not vary with tree size. The proportion of crown weight in wood averaged 78 percent and in bark it averaged 22 percent on both the green and dry bases. For branches, the proportion of green weight in bark increased with decreasing branch size. Branches ≥ 4 inches d.o.b. had 20 percent of their green weight in bark, while branches ≤ 0.5 inches d.o.b. had 32 percent of their green weight in bark.

Dead branches composed 11 percent of crown green weight and 13 percent of crown dry weight.

The change in distribution of crown materials with increasing tree size is shown in figure 1.

PHYSICAL PROPERTIES

Wood and bark specific gravity, moisture content, and green weight per cubic foot for the total tree and its components are presented in table 4. Wood specific gravity and moisture content did not vary significantly with tree size. Wood specific gravity averaged 0.608 for the total tree and 0.595 for the total stem—the same as the value (0.60) reported for the species (Forest Products Laboratory 1974). Branches had the

Table 4.—Average wood and bark specific gravity, moisture content, and green weight per cubic foot for scarlet oak trees and tree components

Tree component	Average and standard deviation		
	Specific gravity	Moisture content	Green weight per cubic foot
		Percent	*Pounds*
WOOD			
Total tree	0.608 ± 0.022	76 ± 4.4	67 ± 1.5
Stem (butt to 4-inch d.i.b. top)	.595 ± .024	80 ± 5.4	67 ± 1.7
Saw log (butt to 8-inch d.i.b. top)	.592 ± .028	83 ± 5.1	68 ± 2.2
Pulpwood (8- to 4-inch d.i.b. top)	.618 ± .026	67 ± 4.8	67 ± 1.9
Topwood (4- to 2-inch d.i.b. top)	.630 ± .027	68 ± 4.8	66 ± 1.9
Branches	.648 ± .027	62 ± 3.2	66 ± 2.4
BARK			
Total tree	0.611 ± 0.027	59 ± 3.1	61 ± 2.7
Stem (butt to 4-inch d.i.b. top)	.629 ± .031	57 ± 4.0	62 ± 2.7
Saw log (butt to 8-inch d.i.b. top)	.624 ± .036	58 ± 4.6	61 ± 3.2
Pulpwood (8- to 4-inch d.i.b. top)	.643 ± .033	56 ± 3.5	63 ± 3.1
Topwood (4- to 2-inch d.i.b. top)	.629 ± .041	58 ± 5.6	62 ± 3.4
Branches	.572 ± .045	62 ± 5.9	58 ± 4.5

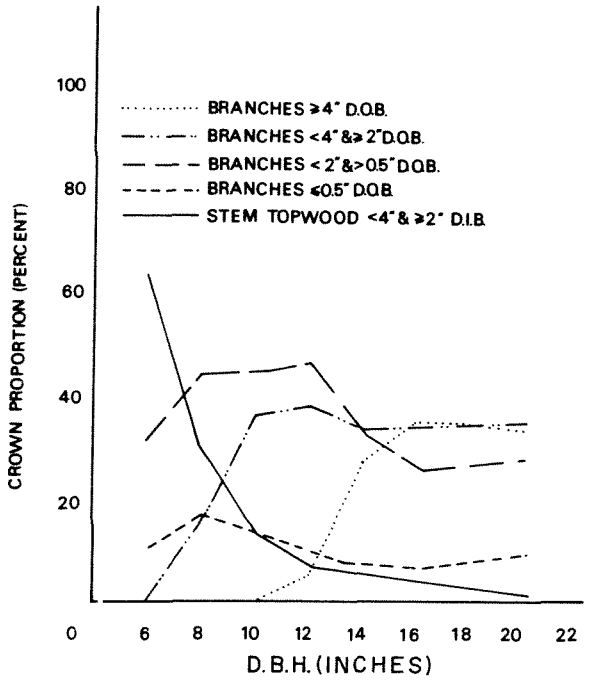

Figure 1.—Proportion of scarlet oak crown weight in topwood and branches, by branch d.o.b. size classes.

highest wood specific gravity, averaging 0.648, and saw-log wood the lowest, averaging 0.592. Average moisture content of wood ranged from 62 percent in the branches to 83 percent in saw logs and averaged 76 percent for all wood in the tree. Green weight per cubic foot of wood averaged 66 pounds in the branches and 67 pounds in the main stem and total tree.

Specific gravity of bark was lowest in branches (0.572) and highest in the pulpwood section of the main stem (0.643). Bark specific gravity in the total tree averaged 0.611—higher than wood specific gravity. Bark moisture content for the total tree averaged 59 percent, which was lower than the corresponding value for wood. Branch bark moisture content was highest, averaging 62 percent, and pulpwood bark was the lowest, averaging 56 percent. Average green bark weight per cubic foot ranged from 58 pounds for branches to 63 pounds for the pulpwood section and averaged 61 pounds for the total tree.

The weight of wood and bark per unit volume of wood is a useful factor for estimating the volume of wood in a tree or its components when weight with bark is known. The average green weight of wood and bark per cubic foot of wood was 79 pounds for the total tree and 78 pounds for the stem (table 5). For branch material, the green weight of wood and bark per cubic foot of wood averaged 84 pounds and was considerably higher than the average for the main stem because

branches contain 36 percent more of their weight in bark.

Green weight per cubic foot of wood and bark combined averaged 66 pounds for the total tree and stem, and 64 pounds for branch material (table 5).

higher coefficients of determination and slightly lower standard errors of estimates than the equations using D^2, D^2H4, or D^2 + Mh.

Equations using D^2 + Mh were the best estimators of saw-log merchantable stem weight and volume, while equations using D^2H4 were the

Table 5.—Average green weight of wood and bark per cubic foot of wood and average green weight of wood and bark per cubic foot of wood and bark for scarlet oak trees and tree components

Tree component	Average and standard deviation	
	Green weight of wood & bark per cubic foot of wood	Green weight of wood & bark per cubic foot of wood & bark
	..... *Pounds*	
Total tree	79 ± 1.7	66 ± 1.4
Stem (butt to 4-inch d.i.b. top)	78 ± 2.3	66 ± 1.4
Saw log (butt to 8-inch d.i.b. top)	77 ± 2.7	67 ± 1.7
Pulpwood (8- to 4-inch d.i.b. top)	79 ± 3.3	66 ± 1.8
Topwood (4- to 2-inch d.i.b. top)	82 ± 3.4	65 ± 1.6
Branches	84 ± 3.0	64 ± 2.6

PREDICTION EQUATIONS

A series of equations was developed to predict weights and volumes of total trees and their components. Since heights of trees are measured to different top limits by various organizations, equations were developed using D^2 alone and in combination with Th, H4, and Mh separately and combined as independent variables. When D^2 and Th or D^2 and H4 were used, the one-variable equation (2) and the two-variable equations (3) predicted total-tree and component weights and volumes equally well. The use of height as a separate variable did not improve the coefficient of determination or reduce the standard error. Thus, the single-variable model was used to predict tree weight and volume when using D^2, D^2Th, and D^2H4 as the independent variable. When D^2 and Mh were used as separate variables in equation (3), the coefficient of determination (R^2) increased 15 to 20 percent and the standard error was reduced. Thus, the two-variable model was used when D^2 and Mh were the independent variables.

All independent variable combinations were good predictors of weights and volumes, but equations using D^2Th were the best for total-tree weight and volume. These equations had slightly best predictors of stem weight and volume to a 4-inch top. When average tree heights and stem taper for d.b.h. classes are similar to those of our sample trees, the equations using d.b.h. alone will result in good estimates of tree weight and volume. However, when average tree heights by d.b.h. classes are different, the equations that include a height variable should be applied directly or used to develop local weight-volume tables based on d.b.h. alone.

Appendix tables 6 and 7 present equations for predicting all weights and volumes measured from D^2Th. Appendix tables 8 and 9 present equations that use D^2, D^2H4, and D^2 + Mh to predict the green weights of wood and bark and volumes of wood for selected tree components of greatest interest. The Appendix also describes a method for placing confidence limits on predictions made with the equations.

A complete list of equations based on D^2, D^2H4, and D^2Mh for predicting the green and dry weights and volumes of wood and bark in all tree components listed in tables 6 and 7 is available from the authors at the Southeastern Forest Experiment Station, Forestry Sciences Laboratory, Carlton Street, Athens, Georgia 30602. Also available are uncorrected sums and sums of squares and their cross products for the inde-

pendent and dependent variables listed in tables 6 and 7. These data make it possible to compare and combine equations statistically. They also allow for the addition of observations and for computation of error terms.

BIOMASS TABLES

Equations based on D^2Th from tables 6 and 7 were used to develop tables of biomass weight and volume. Tables 10–13 show predicted green weights of wood and bark and wood alone in the total tree, the saw-log stem to an 8-inch d.i.b. or saw-log merchantable top, the stem to a 4-inch d.i.b. top, and the crown. Tables 14–17 show predicted green volumes of wood and bark and wood alone in the the total tree and its components. The predicted weight or volume of bark in a tree or component can be estimated by subtracting the value in the table for wood alone from the corresponding value in the table for wood and bark combined.

Similar-sized trees may vary in weight and volume because of differences in crown size, stem taper, and weight per cubic foot. Therefore, the equations and tables should be applied only to trees growing in natural, fully stocked stands that have stem taper rates and weights per cubic foot similar to the trees sampled.

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COMPUTATION OF CONFIDENCE LIMITS

Tables 6, 7, 8, and 9 contain the standard errors of the estimate, the sample mean of x, and the corrected sums of squares for x for each equation in $\log_{10}$ form. These statistics can be used to calculate approximate confidence limits in pounds or cubic feet using a modification of Cox's formula (Land 1972) for estimating confidence limits for lognormal means:

$$Y_{U,L} = 10^{\log Y \pm Z \sqrt{S^2_{y\cdot x}\left[\frac{1}{n} + \frac{(x-\bar{x})^2}{\Sigma(x-\bar{x})^2}\right] + \frac{S^4_{y\cdot x}}{2(n+1)}}} \quad (8)$$

where:

$Y_{U,L}$	=	upper and lower limits for Y,
Y	=	predicted weight or volume of component from equation (6),
Z	=	value from the standard normal table for appropriate confidence level,
$S_{y\cdot x}$	=	standard error of estimate for prediction equation,
n	=	number of observations used to develop equation,
$\bar{x}$	=	sample mean of log x — (from table of equations),
$\Sigma(x-\bar{x})^2$	=	corrected sums of squares for log x — (from table of equations),
x	=	value of independent variable in $\log_{10}$ form.

Cox's method of approximation sufficiently estimates actual confidence limits when applied to samples with small variances as occur in the total tree and stem weight and volume of scarlet oak data sets. Thus, equation (8) should be used to approximate confidence limits for the single-variable equations presented in this Paper.

Appendix

Table 6.—Regression equations for estimating above-stump green and dry weight of the total tree and its components for scarlet oak trees 5 to 20 inches d.b.h. using d.b.h. and total height as independent variables

Weight (Y)	Regression equation[a]	Coefficient of determination (R^2)	Standard error[b] ($S_{y \cdot x}$)[c]	Number trees sampled (N)
Total tree (excluding foliage):				
Green weight	$Y = 0.19275\ (D^2Th)^{1.00974}$	0.99	0.0335	28
Dry weight	$Y = 0.12161\ (D^2Th)^{1.00031}$	.99	.0376	28
All wood in tree:				
Green weight	$Y = 0.15519\ (D^2Th)^{1.01440}$	.99	.0357	28
Dry weight	$Y = 0.09706\ (D^2Th)^{1.00409}$	.99	.0412	28
All bark in tree:				
Green weight	$Y = 0.03789\ (D^2Th)^{0.98688}$	.99	.0424	28
Dry weight	$Y = 0.02451\ (D^2Th)^{0.98391}$	.99	.0434	28
Wood and bark in stem from stump to saw-log merchantable top (trees ≥ 11.0 inches d.b.h.):				
Green weight	$Y = 0.06044\ (D^2Th)^{1.05689}$	.85	.0856	16
Dry weight	$Y = 0.04640\ (D^2Th)^{1.02407}$	.85	.0831	16
Wood in stem from stump to saw-log merchantable top (trees ≥ 11.0 inches d.b.h.):				
Green weight	$Y = 0.04863\ (D^2Th)^{1.06485}$	.86	.0850	16
Dry weight	$Y = 0.03753\ (D^2Th)^{1.02940}$	.86	.0817	16
Bark in stem from stump to saw-log merchantable top (trees ≥ 11.0 inches d.b.h.):				
Green weight	$Y = 0.01304\ (D^2Th)^{1.00505}$	.81	.0948	16
Dry weight	$Y = 0.00903\ (D^2Th)^{0.99591}$	.80	.0979	16
Wood and bark in stem from stump to 8-inch d.i.b. top (trees ≥ 11.0 inches d.b.h.):				
Green weight	$Y = 0.09738\ (D^2Th)^{1.03686}$	.98	.0313	16
Dry weight	$Y = 0.07483\ (D^2Th)^{1.00404}$	.97	.0349	16
Wood in stem from stump to 8-inch d.i.b. top (trees ≥ 11.0 inches d.b.h.):				
Green weight	$Y = 0.07837\ (D^2Th)^{1.04482}$	.98	.0314	16
Dry weight	$Y = 0.06054\ (D^2Th)^{1.00937}$	.97	.0362	16
Bark in stem from stump to 8-inch d.i.b. top (trees ≥ 11.0 inches d.b.h.):				
Green weight	$Y = 0.02099\ (D^2Th)^{0.98502}$	.95	.0441	16
Dry weight	$Y = 0.01452\ (D^2Th)^{0.97588}$	.95	.0453	16
Wood and bark in stem from stump to 4-inch d.i.b. top:				
Green weight	$Y = 0.09079\ (D^2Th)^{1.05414}$	.99	.0437	28
Dry weight	$Y = 0.05905\ (D^2Th)^{1.03882}$	.99	.0478	28
Wood in stem from stump to 4-inch d.i.b. top:				
Green weight	$Y = 0.07333\ (D^2Th)^{1.06140}$	.99	.0444	28
Dry weight	$Y = 0.04678\ (D^2Th)^{1.04597}$	.99	.0504	28

Continued

Table 6.—Regression equations for estimating above-stump green and dry weight of the total tree and its components for scarlet oak trees 5 to 20 inches d.b.h. using d.b.h. and total height as independent variables—Continued

Weight (Y)	Regression equation[a]	Coefficient of determination (R^2)	Standard error[b] ($S_{y \cdot x}$)[c]	Number trees sampled (N)
Bark in stem from stump to 4-inch d.i.b. top:				
Green weight	$Y = 0.01857\ (D^2Th)^{1.00981}$	.98	.0576	28
Dry weight	$Y = 0.01278\ (D^2Th)^{1.00135}$	.98	.0567	28
Wood and bark in crown (all branches and topwood < 4 inches d.i.b.):				
Green weight	$Y = 0.10793\ (D^2Th)^{0.93721}$	.95	.0916	28
Dry weight	$Y = 0.06122\ (D^2Th)^{0.94560}$	.95	.0921	28
Wood in crown (all branches and topwood < 4 inches d.i.b):				
Green weight	$Y = 0.09108\ (D^2Th)^{0.92903}$	.94	.0959	28
Dry weight	$Y = 0.05135\ (D^2Th)^{0.93779}$	.94	.0958	28
Bark in crown (all branches and topwood < 4 inches d.i.b):				
Green weight	$Y = 0.01706\ (D^2Th)^{0.97136}$	.95	.0945	28
Dry weight	$Y = 0.01004\ (D^2Th)^{0.97688}$	.95	.0954	28
Wood and bark in crown ≥ 2 inches d.o.b.:				
Green weight	$Y = 0.02185\ (D^2Th)^{1.04830}$	.86	.1695	28
Dry weight	$Y = 0.01186\ (D^2Th)^{1.06012}$	.87	.1661	28
Wood in crown ≥ 2.0 inches d.o.b.:				
Green weight	$Y = 0.02021\ (D^2Th)^{1.03447}$	.86	.1723	28
Dry weight	$Y = 0.01058\ (D^2Th)^{1.04924}$	.87	.1688	28
Bark in crown ≥ 2.0 inches d.o.b.:				
Green weight	$Y = 0.00220\ (D^2Th)^{1.11432}$	.88	.1646	28
Dry weight	$Y = 0.00144\ (D^2Th)^{1.10983}$	.88	.1644	28
Wood and bark in dead branches				
Green weight	$Y = 0.00495\ (D^2Th)^{1.03807}$	.87	.1618	28
Dry weight	$Y = 0.00480\ (D^2Th)^{1.01072}$	.85	.1737	28

[a] $Y = b_0(D^2Th)^{b_1}$

where:

Y = component weight in pounds,
D = d.b.h. in inches,
Th = Total tree height in feet,
b_0 and b_1 = regression coefficients.

[b] Standard error in $\log_{10}$ form.

[c] Additional statistics for computation of confidence intervals:

$\Sigma(x-\bar{x})^2 = 4.3559$ and $\bar{x} = 3.9631$ for equations based on 28 trees, and
$\Sigma(x-\bar{x})^2 = 0.5386$ and $\bar{x} = 4.2520$ for equations based on 16 trees.

Table 7.—Regression equations for estimating above-stump green cubic-foot volume of the total tree and its components for scarlet oak trees 5 to 20 inches d.b.h. using d.b.h. and total height as independent variables

Cubic-foot volume (Y)	Regression equation[a]	Coefficient of determination (R^2)	Standard error[b] ($S_{y \cdot x}$)[c]	Number trees sampled (N)
Total tree (excluding foliage):				
Wood	$Y = 0.00233\ (D^2Th)^{1.01465}$	0.99	0.0353	28
Bark	$Y = 0.00086\ (D^2Th)^{0.95266}$	.99	.0439	28
Wood & bark	$Y = 0.00311\ (D^2Th)^{1.00368}$	.99	.0335	28
Stem from stump to saw log merchantable top (trees ≥ 11.0 inches d.b.h.):				
Wood	$Y = 0.00054\ (D^2Th)^{1.09480}$	.87	.0824	16
Bark	$Y = 0.00027\ (D^2Th)^{0.97983}$	.80	.0966	16
Wood & bark	$Y = 0.00074\ (D^2Th)^{1.07831}$	.87	.0834	16
Stem from stump to 8-inch d.i.b. top (trees ≥ 11.0 inches d.b.h.):				
Wood	$Y = 0.00087\ (D^2Th)^{1.07477}$	.98	.0336	16
Bark	$Y = 0.00043\ (D^2Th)^{0.95980}$	.95	.0414	16
Wood & bark	$Y = 0.00119\ (D^2Th)^{1.05828}$	.98	.0317	16
Stem from stump to 4-inch d.i.b. top:				
Wood	$Y = 0.00104\ (D^2Th)^{1.06736}$	.99	.0419	28
Bark	$Y = 0.00040\ (D^2Th)^{0.97815}$	.98	.0569	28
Wood & bark	$Y = 0.00137\ (D^2Th)^{1.05401}$	.99	.0413	28
Crown (all branches and topwood < 4 inches d.i.b. excluding foliage):				
Wood	$Y = 0.00153\ (D^2Th)^{0.91833}$	.94	.0972	28
Bark	$Y = 0.00040\ (D^2Th)^{0.93593}$	.94	.1004	28
Wood & bark	$Y = 0.00194\ (D^2Th)^{0.92165}$	.94	.0941	28
Crown material ≥ 2.0 inches d.o.b.:				
Wood	$Y = 0.00033\ (D^2Th)^{1.02852}$	.86	.1720	28
Bark	$Y = 0.00005\ (D^2Th)^{1.08727}$	.88	.1672	28
Wood & bark	$Y = 0.00037\ (D^2Th)^{1.03921}$	.86	.1699	28
Dead branch material:				
Wood & bark	$Y = 0.00014\ (D^2Th)^{1.01008}$	.84	.1817	28

[a] $Y = b_0(D^2Th)^{b_1}$

where:

Y = component volume in cubic feet,
D = d.b.h. in inches,
Th = total tree height in feet,
b_0 and b_1 = regression coefficients.

[b] Standard error of estimates in $\log_{10}$ form.

[c] Additional statistics for computation of confidence intervals:

$\Sigma(x-\bar{x})^2 = 4.3559$ and $\bar{x} = 3.9631$ for equations based on 28 trees, and
$\Sigma(x-\bar{x})^2 = 0.5386$ and $\bar{x} = 4.4520$ for equations based on 16 trees.

Table 8.—Regression equations for estimating the above-stump wood and bark green weight for scarlet oak trees 5 to 20 inches d.b.h. and tree component parts using d.b.h., d.b.h. and height to 4-inch top, and d.b.h. and saw-log merchantable height as independent variables

Weight (Y)	Regression equation[a]	Coefficient of determination (R^2)	Standard error[b] ($S_{y \cdot x}$)	Sample mean of x[b] ($\bar{x}$)	Corrected sums of squares for x[b] $\Sigma(x-\bar{x})^2$	Number trees sampled (N)
Wood and bark in total tree above stump						
	$Y = 5.40549\ (D^2)^{1.21189}$	0.99	0.0411	2.1076	3.0139	28
	$Y = 1.36696\ (D^2H4)^{0.83664}$	.98	.0512	3.7671	6.2893	28
	$Y = 7.89942\ (D^2)^{1.14430}\ (Mh)^{-0.00098}$	.96	.0396	—	—	16
Wood and bark in stem from stump to saw-log merchantable top						
	$Y = 1.53071\ (D^2)^{1.31601}$	.83	.0923	2.3487	0.3377	16
	$Y = 0.24149\ (D^2H4)^{0.94792}$	.86	.0848	4.1060	0.6715	16
	$Y = 0.72165\ (D^2)^{0.96023}\ (Mh)^{0.79487}$	.99	.0171	—	—	16
Wood and bark in stem from stump to 4-inch d.i.b. top						
	$Y = 2.94471\ (D^2)^{1.26540}$	.99	.0497	2.1076	3.0139	28
	$Y = 0.66554\ (D^2H4)^{0.87923}$	.99	.0329	3.7671	6.2893	28
	$Y = 5.41150\ (D^2)^{1.09545}\ (Mh)^{0.09157}$	.95	.0408	—	—	16
Wood and bark in crown (all branches and top-wood < 4 inches d.i.b.)						
	$Y = 2.36491\ (D^2)^{1.12626}$	.94	.0922	2.1076	3.0139	28
	$Y = 0.72649\ (D^2H4)^{0.76682}$	.91	.1154	3.7671	6.2893	28
	$Y = 2.58978\ (D^2)^{1.26409}\ (Mh)^{-0.23979}$	.91	.0588	—	—	16

[a] $Y = a(D^2)^{b_1}$ or $Y = a(D^2H4)^{b_2}$ or $Y = a(D^2)^{b_1}(Mh)^{b_2}$.

where:

Y = component weight in pounds,
D = d.b.h. in inches,
H4 = tree height to 4-inch d.i.b. top in feet,
Mh = saw-log merchantable height in feet,
a, b_1, b_2 = regression coefficients.

[b] $\log_{10}$ form.

Table 9.—Regression equations for estimating the above-stump wood volume for scarlet oak trees 5 to 20 inches d.b.h. and tree component parts using d.b.h., d.b.h. and height to 4-inch top, and d.b.h. and saw-log merchantable height as independent variables

Cubic-foot volume (Y)	Regression equation[a]	Coefficient of determination (R^2)	Standard error[b] ($S_{y \cdot x}$)	Sample mean of x^b ($\bar{x}$)	Corrected sums of squares for x^b $\Sigma(x-\bar{x})^2$	Number trees sampled (N)
Wood in total tree above stump						
	$Y = 0.06656\,(D^2)^{1.21701}$	0.99	0.0452	2.1076	3.0139	28
	$Y = 0.01674\,(D^2H4)^{0.84014}$	.98	.0547	3.7671	6.2893	28
	$Y = 0.08866\,(D^2)^{1.18273}\,(Mh)^{-0.02745}$	.95	.0447	—	—	16
Wood in stem from stump to saw-log merchantable top						
	$Y = 0.01580\,(D^2)^{1.35893}$	.84	.0914	2.3487	0.3377	16
	$Y = 0.00230\,(D^2H4)^{0.98075}$	.87	.0823	4.1060	0.6715	16
	$Y = 0.00760\,(D^2)^{1.01280}\,(Mh)^{0.77330}$	.99	.0244	—	—	16
Wood in stem from stump to 4-inch d.i.b. top						
	$Y = 0.03530\,(D^2)^{1.28039}$	.99	.0509	2.1076	3.0139	28
	$Y = 0.00784\,(D^2H4)^{0.88967}$	.99	.0341	3.7671	6.2893	28
	$Y = 0.05793\,(D^2)^{1.14656}\,(Mh)^{0.06683}$	.94	.0466	—	—	16
Wood in crown (all branches and top-wood < 4 inches d.i.b.)						
	$Y = 0.03148\,(D^2)^{1.103612}$	.94	.0977	2.1076	3.0139	28
	$Y = 0.01001\,(D^2H4)^{0.75024}$	.90	.1208	3.7671	6.2893	28
	$Y = 0.03349\,(D^2)^{1.28174}\,(Mh)^{-0.29670}$	.91	.0578	—	—	16

[a] $Y = a(D^2)^{b_1}$ or $Y = a(D^2H4)^{b_2}$ or $Y = a(D^2)^{b_1}(Mh)^{b_2}$.

where:

Y = component volume in cubic feet,
D = d.b.h. in inches,
H4 = tree height to 4-inch d.i.b. top in feet,
Mh = saw-log merchantable height in feet,
a, b_1, b_2 = regression coefficients.

[b] $\log_{10}$ form.

Table 10.—Predicted green weight of above-stump total-tree wood and bark for scarlet oak trees[1]

D.b.h. (inches)	Total-tree height[2] (feet)						
	40	50	60	70	80	90	100
	Pounds						
	WOOD AND BARK[3]						
5	206	258	310	363	415		
6	298	373	449	524	600		
7	407	510	613	716	819		
8	533	667	802	937	1,073	1,208	
9	676	846	1,018	1,189	1,361	1,532	
10	836	1,047	1,259	1,471	1,683	1,896	2,109
11	1,013	1,269	1,526	1,783	2,040	2,298	2,556
12	1,208	1,513	1,819	2,126	2,432	2,740	3,047
13	1,420	1,779	2,138	2,498	2,859	3,220	3,582
14		2,066	2,484	2,902	3,321	3,740	4,160
15		2,375	2,855	3,336	3,817	4,299	4,782
16		2,705	3,252	3,800	4,348	4,898	5,447
17		3,058	3,676	4,295	4,915	5,536	6,157
18			4,126	4,820	5,516	6,213	6,910
19			4,602	5,377	6,153	6,930	7,708
20			5,104	5,963	6,824	7,686	8,549
21			5,632	6,581	7,531	8,482	9,434
22			6,187	7,229	8,273	9,317	10,363
	WOOD[4]						
5	171	215	259	302	346		
6	248	311	374	438	501		
7	339	425	512	599	685		
8	445	558	671	785	899	1,013	
9	565	708	852	997	1,141	1,286	
10	700	877	1,055	1,234	1,413	1,592	1,772
11	849	1,064	1,281	1,497	1,714	1,932	2,150
12	1,013	1,270	1,528	1,786	2,045	2,305	2,565
13	1,191	1,494	1,797	2,101	2,406	2,712	3,017
14		1,736	2,089	2,442	2,797	3,151	3,507
15		1,997	2,403	2,809	3,217	3,625	4,034
16		2,276	2,739	3,202	3,667	4,132	4,598
17		2,574	3,097	3,621	4,147	4,673	5,200
18			3,478	4,067	4,656	5,247	5,839
19			3,881	4,538	5,196	5,856	6,516
20			4,307	5,036	5,766	6,498	7,231
21			4,755	5,560	6,366	7,174	7,983
22			5,225	6,110	6,996	7,884	8,773

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$Y = 0.19275\ (D^2Th)^{1.00974}$.
[4]$Y = 0.15519\ (D^2Th)^{1.01440}$.

Table 11.—Predicted green weight of wood and bark in saw-log stem to 8-inch d.i.b. or saw-log merchantable top for scarlet oak trees[1]

D.b.h. (inches)	Total-tree height[2] (feet)					
	50	60	70	80	90	100
	Pounds					
	WOOD AND BARK[3]					
11	600	728	856	986	1,117	1,248
12	721	874	1,029	1,185	1,342	1,500
13	854	1,036	1,219	1,404	1,590	1,777
14	999	1,211	1,426	1,642	1,859	2,078
15	1,156	1,401	1,649	1,899	2,151	2,405
16	1,325	1,606	1,890	2,177	2,466	2,756
17	1,506	1,826	2,149	2,475	2,803	3,133
18		2,060	2,425	2,792	3,163	3,535
19		2,310	2,718	3,130	3,545	3,963
20		2,574	3,030	3,489	3,951	4,417
21		2,854	3,359	3,868	4,381	4,897
22		3,149	3,706	4,268	4,833	5,403
	WOOD[4]					
11	517	628	740	854	968	1,083
12	623	756	891	1,027	1,165	1,303
13	739	897	1,057	1,218	1,381	1,545
14	865	1,050	1,238	1,427	1,617	1,809
15	1,002	1,216	1,433	1,652	1,873	2,096
16	1,149	1,396	1,645	1,896	2,149	2,404
17	1,308	1,588	1,871	2,157	2,445	2,736
18		1,794	2,114	2,436	2,762	3,090
19		2,012	2,371	2,734	3,099	3,467
20		2,245	2,645	3,049	3,457	3,867
21		2,491	2,935	3,383	3,835	4,291
22		2,750	3,241	3,736	4,235	4,738

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$Y = 0.06044\ (D^2Th)^{1.05689}$.
[4]$Y = 0.04863\ (D^2Th)^{1.06485}$.

Table 12.—Predicted green weight of wood and bark in stem to 4-inch d.i.b. top for scarlet oak trees[1]

D.b.h. (inches)	Total-tree height[2] (feet)						
	40	50	60	70	80	90	100
	Pounds						
	WOOD AND BARK[3]						
5	132	167	202	238	274		
6	194	245	297	350	402		
7	268	339	411	484	557		
8	355	450	545	641	738	836	
9	456	576	699	822	946	1,071	
10	569	720	872	1,026	1,182	1,338	1,495
11	696	880	1,067	1,255	1,444	1,635	1,828
12	836	1,057	1,281	1,507	1,735	1,965	2,195
13	989	1,252	1,517	1,785	2,054	2,326	2,599
14		1,463	1,773	2,086	2,402	2,719	3,039
15		1,692	2,051	2,413	2,778	3,145	3,514
16		1,939	2,350	2,765	3,183	3,603	4,027
17		2,204	2,670	3,142	3,616	4,095	4,576
18			3,012	3,544	4,080	4,619	5,162
19			3,376	3,972	4,572	5,177	5,785
20			3,762	4,425	5,094	5,768	6,445
21			4,169	4,905	5,646	6,393	7,144
22			4,599	5,410	6,228	7,052	7,880
	WOOD[4]						
5	112	142	172	203	234		
6	165	209	254	299	344		
7	229	290	352	415	478		
8	304	385	467	550	634	719	
9	390	495	600	707	814	923	
10	488	619	751	884	1,019	1,154	1,291
11	598	757	919	1,082	1,247	1,413	1,580
12	719	911	1,105	1,302	1,500	1,700	1,901
13	852	1,080	1,310	1,543	1,778	2,015	2,253
14		1,263	1,533	1,806	2,081	2,358	2,637
15		1,463	1,775	2,091	2,409	2,730	3,053
16		1,678	2,036	2,398	2,763	3,131	3,501
17		1,908	2,315	2,727	3,142	3,560	3,982
18			2,614	3,079	3,547	4,020	4,495
19			2,932	3,453	3,979	4,509	5,042
20			3,269	3,850	4,437	5,027	5,622
21			3,626	4,270	4,921	5,576	6,236
22			4,002	4,714	5,431	6,155	6,883

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$Y = 0.09079\ (D^2Th)^{1.05414}$.
[4]$Y = 0.07333\ (D^2Th)^{1.06140}$.

Table 13.—Predicted green weight of wood and bark in crown for scarlet oak trees[1]

D.b.h. (inches)	Total-tree height[2] (feet)						
	40	50	60	70	80	90	100
	Pounds						
	WOOD AND BARK[3]						
5	70	86	102	118	134		
6	98	121	144	166	189		
7	131	162	192	222	252		
8	169	208	247	285	323	361	
9	211	259	308	356	403	450	
10	256	316	375	433	491	548	605
11	307	378	448	518	587	656	724
12	361	445	528	610	691	772	852
13	419	517	613	709	803	897	990
14		594	705	814	923	1,030	1,137
15		676	802	927	1,050	1,173	1,294
16		763	905	1,046	1,185	1,323	1,461
17		855	1,014	1,172	1,328	1,483	1,637
18			1,129	1,304	1,478	1,650	1,822
19			1,249	1,443	1,636	1,826	2,016
20			1,375	1,589	1,801	2,011	2,219
21			1,507	1,741	1,973	2,203	2,432
22			1,644	1,900	2,153	2,404	2,654
	WOOD[4]						
5	56	69	81	94	106		
6	78	96	114	132	149		
7	104	128	152	175	198		
8	134	164	195	225	254	284	
9	166	205	242	280	317	353	
10	202	249	295	340	385	430	474
11	241	297	352	406	460	513	566
12	284	349	414	477	540	603	665
13	329	405	480	554	627	699	771
14		465	551	636	719	803	885
15		529	626	722	818	912	1,006
16		596	706	815	922	1,029	1,135
17		667	790	912	1,032	1,151	1,270
18			879	1,014	1,148	1,280	1,412
19			971	1,121	1,269	1,416	1,561
20			1,068	1,233	1,396	1,557	1,717
21			1,170	1,350	1,528	1,705	1,880
22			1,275	1,472	1,666	1,859	2,050

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$Y = 0.10793\ (D^2Th)^{0.93721}$.
[4]$Y = 0.09108\ (D^2Th)^{0.92903}$.

Table 14.—Predicted volume of above-stump total-tree wood and bark for scarlet oak trees[1]

D.b.h. (inches)	Total-tree height[2] (feet)						
	40	50	60	70	80	90	100
	Cubic feet						
	WOOD AND BARK[3]						
5	3.2	4.0	4.8	5.6	6.4		
6	4.6	5.8	6.9	8.1	9.2		
7	6.3	7.8	9.4	11.0	12.6		
8	8.2	10.3	12.3	14.4	16.4	18.5	
9	10.4	13.0	15.6	18.2	20.8	23.4	
10	12.8	16.0	19.3	22.5	25.7	28.9	32.2
11	15.5	19.4	23.3	27.2	31.1	35.0	39.0
12	18.5	23.1	27.8	32.4	37.1	41.7	46.4
13	21.7	27.2	32.6	38.1	43.5	49.0	54.5
14		31.5	37.9	44.2	50.5	56.9	63.2
15		36.2	43.5	50.8	58.0	65.3	72.6
16		41.2	49.5	57.8	66.1	74.4	82.6
17		46.6	55.9	65.3	74.6	84.0	93.3
18			62.7	73.2	83.7	94.2	104.7
19			69.9	81.6	93.3	105.0	116.7
20			77.5	90.4	103.4	116.4	129.3
21			85.4	99.7	114.0	128.3	142.7
22			93.8	109.5	125.2	140.9	156.6
	WOOD[4]						
5	2.6	3.2	3.9	4.5	5.2		
6	3.7	4.7	5.6	6.6	7.5		
7	5.1	6.4	7.7	9.0	10.3		
8	6.7	8.4	10.1	11.8	13.5	15.2	
9	8.5	10.7	12.8	15.0	17.2	19.3	
10	10.5	13.2	15.9	18.6	21.3	24.0	26.7
11	12.8	16.0	19.3	22.5	25.8	29.1	32.4
12	15.2	19.1	23.0	26.9	30.8	34.7	38.6
13	17.9	22.5	27.0	31.6	36.2	40.8	45.4
14		26.1	31.4	36.8	42.1	47.4	52.8
15		30.1	36.2	42.3	48.4	54.6	60.7
16		34.3	41.2	48.2	55.2	62.2	69.2
17		38.7	46.6	54.5	62.4	70.3	78.3
18			52.3	61.2	70.1	79.0	87.9
19			58.4	68.3	78.2	88.1	98.1
20			64.8	75.8	86.8	97.8	108.9
21			71.6	83.7	95.8	108.0	120.2
22			78.7	92.0	105.3	118.7	132.1

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$Y = 0.00311\ (D^2Th)^{1.00368}$.
[4]$Y = 0.00233\ (D^2Th)^{1.01465}$.

Table 15.—Predicted volume of wood and bark in saw-log stem to 8-inch d.i.b. or saw-log merchantable top for scarlet oak trees[1]

D.b.h. (inches)	Total-tree height[2] (feet)					
	50	60	70	80	90	100
	Cubic feet					
	WOOD AND BARK[3]					
11	8.9	10.8	12.7	14.7	16.7	18.7
12	10.7	13.0	15.4	17.7	20.1	22.6
13	12.7	15.5	18.2	21.1	23.9	26.8
14	14.9	18.1	21.4	24.7	28.1	31.4
15	17.3	21.0	24.8	28.7	32.6	36.5
16	19.9	24.2	28.6	33.0	37.4	41.9
17	22.6	27.6	32.5	37.6	42.7	47.8
18		31.2	36.8	42.5	48.3	54.1
19		35.0	41.4	47.8	54.2	60.8
20		39.1	46.2	53.4	60.6	67.9
21		43.5	51.3	59.3	67.3	75.4
22		48.1	56.7	65.5	74.4	83.4
	WOOD[4]					
11	7.5	9.1	10.8	12.5	14.2	15.9
12	9.0	11.0	13.0	15.1	17.2	19.3
13	10.8	13.1	15.5	18.0	20.5	23.0
14	12.6	15.4	18.3	21.2	24.1	27.0
15	14.7	18.0	21.3	24.6	28.0	31.4
16	16.9	20.7	24.5	28.3	32.2	36.2
17	19.3	23.6	28.0	32.4	36.8	41.3
18		26.8	31.7	36.7	41.7	46.8
19		30.1	35.7	41.3	47.0	52.7
20		33.7	39.9	46.2	52.6	59.0
21		37.5	44.4	51.4	58.5	65.6
22		41.5	49.2	56.9	64.8	72.7

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$Y = 0.00074 (D^2Th)^{1.07831}$.
[4]$Y = 0.00054 (D^2Th)^{1.09480}$.

Table 16.—Predicted volume of wood and bark in stem to 4-inch d.i.b. top for scarlet oak trees[1]

D.b.h. (inches)	Total-tree height[2] (feet)						
	40	50	60	70	80	90	100
	Cubic feet						
	WOOD AND BARK[3]						
5	2.0	2.5	3.1	3.6	4.1		
6	2.9	3.7	4.5	5.3	6.1		
7	4.0	5.1	6.2	7.3	8.4		
8	5.4	6.8	8.2	9.7	11.1	12.6	
9	6.9	8.7	10.5	12.4	14.3	16.1	
10	8.6	10.9	13.2	15.5	17.8	20.2	22.5
11	10.5	13.3	16.1	18.9	21.8	24.6	27.5
12	12.6	15.9	19.3	22.7	26.2	29.6	33.1
13	14.9	18.9	22.9	26.9	31.0	35.1	39.2
14		22.1	26.7	31.4	36.2	41.0	45.8
15		25.5	30.9	36.4	41.9	47.4	53.0
16		29.2	35.4	41.7	48.0	54.3	60.7
17		33.2	40.2	47.3	54.5	61.7	69.0
18			45.4	53.4	61.5	69.6	77.8
19			50.9	59.9	68.9	78.0	87.2
20			56.7	66.7	76.8	86.9	97.1
21			62.8	73.9	85.1	96.3	107.6
22			69.3	81.5	93.9	106.3	118.7
	WOOD[4]						
5	1.7	2.1	2.6	3.0	3.5		
6	2.4	3.1	3.8	4.4	5.1		
7	3.4	4.3	5.2	6.2	7.1		
8	4.5	5.7	7.0	8.2	9.5	10.7	
9	5.8	7.4	9.0	10.6	12.2	13.8	
10	7.3	9.2	11.2	13.2	15.2	17.3	19.3
11	8.9	11.3	13.7	16.2	18.7	21.2	23.7
12	10.7	13.6	16.5	19.5	22.5	25.5	28.5
13	12.7	16.2	19.6	23.1	26.7	30.3	33.9
14		18.9	23.0	27.1	31.3	35.4	39.7
15		21.9	26.6	31.4	36.2	41.1	46.0
16		25.2	30.6	36.0	41.6	47.1	52.7
17		28.6	34.8	41.0	47.3	53.7	60.0
18			39.3	46.4	53.5	60.6	67.8
19			44.1	52.0	60.0	68.0	76.1
20			49.2	58.0	66.9	75.9	84.9
21			54.6	64.4	74.3	84.2	94.3
22			60.3	71.1	82.0	93.0	104.1

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$Y = 0.00119\ (D^2Th)^{1.05828}$.
[4]$Y = 0.00104\ (D^2Th)^{1.06736}$.

Table 17.—Predicted volume of wood and bark in crown for scarlet oak trees[1]

D.b.h. (inches)	Total-tree height[2] (feet)						
	40	50	60	70	80	90	100
	Cubic feet						
	WOOD AND BARK[3]						
5	1.1	1.4	1.6	1.9	2.1		
6	1.6	1.9	2.3	2.6	3.0		
7	2.1	2.6	3.1	3.5	4.0		
8	2.7	3.3	3.9	4.5	5.1	5.7	
9	3.3	4.1	4.8	5.6	6.3	7.0	
10	4.1	5.0	5.9	6.8	7.7	8.6	9.4
11	4.8	5.9	7.0	8.1	9.1	10.2	11.2
12	5.7	7.0	8.2	9.5	10.7	12.0	13.2
13	6.6	8.1	9.5	11.0	12.4	13.9	15.3
14		9.3	10.9	12.6	14.3	15.9	17.5
15		10.5	12.4	14.3	16.2	18.1	19.9
16		11.8	14.0	16.1	18.3	20.3	22.4
17		13.2	15.7	18.0	20.4	22.8	25.1
18			17.4	20.1	22.7	25.3	27.9
19			19.2	22.2	25.1	27.9	30.8
20			21.1	24.4	27.5	30.7	33.8
21			23.1	26.6	30.1	33.6	37.0
22			25.2	29.0	32.8	36.6	40.3
	WOOD[4]						
5	0.9	1.1	1.3	1.5	1.6		
6	1.2	1.5	1.8	2.0	2.3		
7	1.6	2.0	2.3	2.7	3.1		
8	2.1	2.5	3.0	3.4	3.9	4.3	
9	2.6	3.1	3.7	4.3	4.8	5.4	
10	3.1	3.8	4.5	5.2	5.9	6.5	7.2
11	3.7	4.5	5.4	6.2	7.0	7.8	8.6
12	4.3	5.3	6.3	7.3	8.2	9.1	10.1
13	5.0	6.2	7.3	8.4	9.5	10.6	11.7
14		7.1	8.4	9.6	10.9	12.1	13.4
15		8.0	9.5	10.9	12.4	13.8	15.2
16		9.0	10.7	12.3	13.9	15.5	17.1
17		10.1	12.0	13.8	15.6	17.3	19.1
18			13.3	15.3	17.3	19.3	21.2
19			14.7	16.9	19.1	21.3	23.4
20			16.1	18.6	21.0	23.4	25.8
21			17.6	20.3	23.0	25.6	28.2
22			19.2	22.1	25.0	27.9	30.7

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$Y = 0.00194\ (D^2Th)^{0.92165}$.
[4]$Y = 0.00153\ (D^2Th)^{0.91833}$.

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Clark, Alexander, III, Douglas R. Phillips, and Harry C. Hitchcock III.
1980. Predicted weights and volumes of scarlet oak trees on the Tennessee Cumberland Plateau. USDA For. Serv., Res. Pap. SE-214, 23 p. Southeast. For. Exp. Stn., Asheville, N.C.

Equations are presented for predicting green and dry weight and green volume of the total tree above stump and its components using d.b.h. and total height, d.b.h. and height to a 4-inch top, d.b.h. and saw-log merchantable height, and d.b.h. alone. Tables developed from equations show weight and volume of the total tree and its components by d.b.h. and total height class.

KEYWORDS: *Quercus coccinea* Muenchh., biomass, component proportions, equations, specific gravity, moisture content, weight per cubic foot.

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